Capacitance of Activated Carbon Cloth Electrodes in Aqueous Acidic Solutions

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Introduction

Electric double layer capacitors (EDLCs) have been used for memory back up electric sources for personal computers ,toys and others. At present time, application of EDLCs is expected on electric sources for hybrid systems of electric vehicles, energy recovery in elevators, and so on. The electrolyte solutions of these EDLCs are aqueous 30-35 wt% sulfuric acid , organic electrolyte solutions consisting of aprotic solvent containing ammonium or phosphonium salts. The authors[1)] reported EDLCs with aqueous HCl solutions. The capacitance of these EDLCs is large and the possibility of high power use is expected. In the present work, the capacitance and performance of the positive and negative electrodes of activated carbon cloth were measured in aqueous solutions of single and mixed acids and favorable results were obtained.

Experimental

The electrolyte solutions were aqueous solutions of single or mixed aqueous solutions of HCl, H_3PO_4, $HClO_4$, $LaCl_3$ and others. A test cell was a three electrode cell. An activated carbon cloth for the electrode was Toyobo BW554 whose surface area measured by BET was $1130m^2 \cdot g^{-1}$. A current collector was a platinum plate. The apparent surface area of the test electrode was $1.0cm^2$, and the activated carbon cloth and current collector were bound using engineering plastic from Sumitomo Bakelite which was a composite of fine carbon powder and plastic binder. The weight of carbon was $26mg \cdot cm^{-2}$. The counter electrode was an activated carbon cloth electrode with large apparent surface area. The reference electrode was a SCE. The capacitance, coulombic efficiency, and charge-discharge cycling performance etc. were investigated at ambient temperature. Normal charging current density was $3.0mA \cdot cm^{-2}$ and discharging current density was varied between 5.0 and $80.0mA \cdot cm^{-2}$. Operating voltage was 0.05～0.35V and 0.55～0.85V vs SCE on the negative and positive electrodes respectively. The potential window of the carbon test electrode without charging current of the electric double layer was between –0.15 and +1.05V vs SCE in $2mol \cdot dm^{-3}$ HCl.

Results and Discussion

Figure 1 and 2 show the discharge capacitance of the test electrode in 2mol HCl / 1/3mol $H_3PO_4 \cdot dm^{-3}$ solution. As shown in the figures, large capacitance was obtained even on high current discharge. The capacitance increased in the mixed acid solutions. Usually, the capacitance of the negative electrodes was larger than that of the positive electrodes due to the different adsorbability of the ions.

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1) Y. Matsuda, R. Tsuda, and M. Mori, Fall Meeting Electrochem. Soc. Jpn, Abst, p.116 (2000); Electrochemistry (Denki Kagaku) in press.

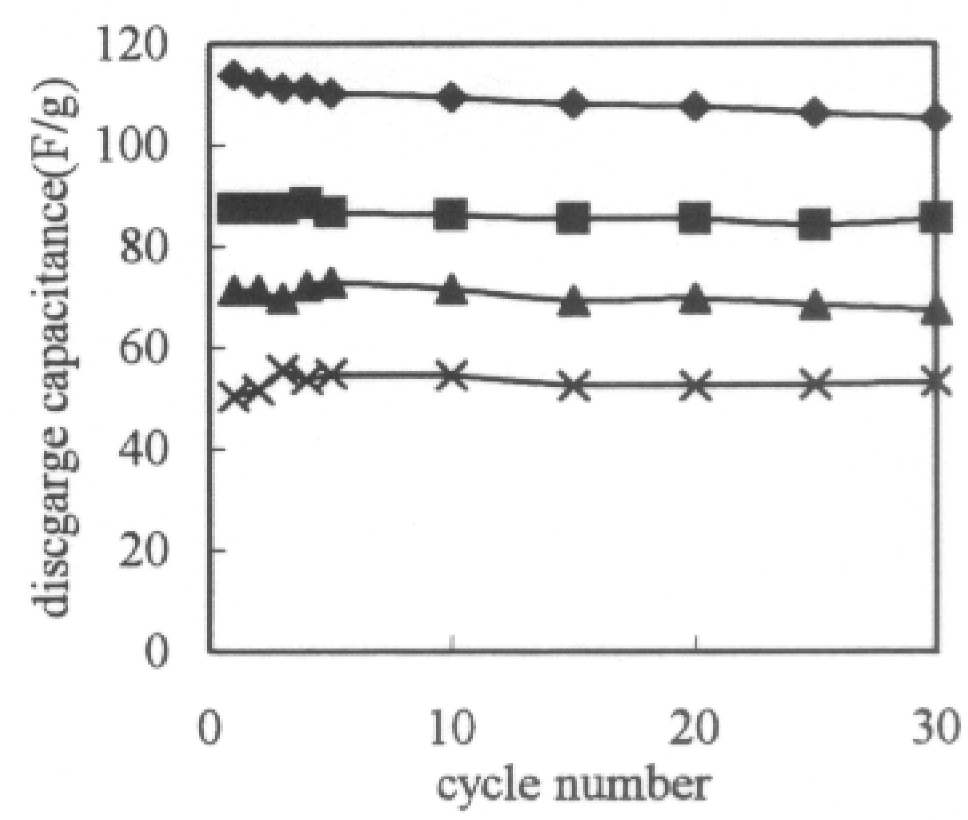

Fig.1 Discharge capacitance of positive electrode
Electrolyte:1/3mol-H_3PO_4/ 2mol-$HCl \cdot dm^{-3}$
Charge current density : $5mA/cm^2$
Discharge current density :
◆$10mA/cm^2$ ■$20mA/cm^2$
▲$40mA/cm^2$ ×$80mA/cm^2$

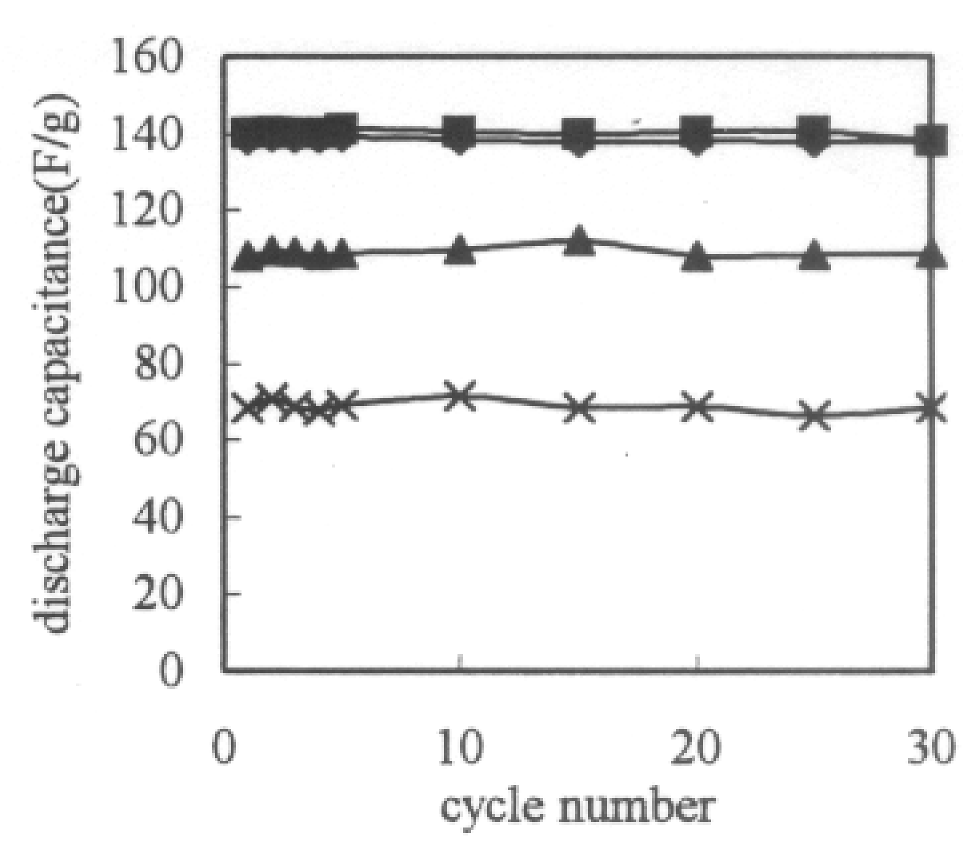

Fig.2 Discharge capacitance of negative electrode
Electrolyte:1/3mol-H_3PO_4/ 2mol-$HCl \cdot dm^{-3}$
Charge current density : $5mA/cm^2$
Discharge current density :
◆$10mA/cm^2$ ■$20mA/cm^2$
▲$40mA/cm^2$ ×$80mA/cm^2$